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A QUANTITATIVE MINERALOGICAL CLASSIFICATION OF IGNEOUS ROCKS—REVISED

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PART III

CLASS 2, ORDER 3

(237) **Calci**granite. No plutonic rock falling near the center point of this family has yet been located.

Quartz-ciminite. Among the extrusives the only rock found in this family is a quartz-bearing ciminite described by Washington.[1] Ciminite, named from its occurrence on Monti Cimini, Italy, was defined[2] as consisting of alkali feldspar, basic plagioclase, augite, and olivine, with accessory magnetite and apatite. From two modal analyses given, it appears that there are quartz-bearing and quartz-free ciminites; consequently the two divisions, quartz-ciminite and ciminite, are here made. A modal analysis of one rock, here called quartz-ciminite, gives orthoclase (Or_6Ab_1) 43.6 per cent, labradorite (Ab_1An_2) 16.1 per cent, quartz 4.6 per cent, apatite 0.7 per cent, augite 22.4 per cent, olivine 11.7 per cent, and magnetite 0.9 per cent. Since this rock contains olivine, it is not representative of the normal extrusives of the family.

(238) **Calci**adamellite. This is a quartz-monzonite whose plagioclase is labradorite. Here fall four specimens from the Elkhorn district, Montana, on the border of the Butte batholith, described by Barrell.[3] The rock, however, is near the border line between Orders 2 and 3. The plagioclase is described as

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[1] Henry S. Washington, "Italian Petrological Sketches, II: The Viterbo Region," *Jour. Geol.*, IV (1896), 838.

[2] *Ibid.*, V (1897), 351; "The Roman Comagmatic Region," *Carnegie Publication No. 57* (Washington, 1906), p. 65.

[3] Joseph Barrell, "Microscopical Petrography of the Elkhorn Mining District, Jefferson County, Montana," *U.S. Geol. Surv., Ann. Rept.*, XXII, Part II (1901), p. 538.

"Ab_1An_1 or more basic" by Barrell. On the other hand, Cross, Iddings, Pirsson, and Washington[1] assume, by calculation from the chemical analysis of a specimen from the Butte region, that the plagioclase has Ab_1An_1 centers but more acid borders. The orthoclase in their analysis, however, was calculated as pure potash feldspar, while as a matter of fact it contains considerable soda. Consequently the plagioclase may be, as Barrell says, more basic, and the C.I.P.W. rock would fall in the calciadamellite family with Barrell's rock.

(239) Granogabbro Johannsen.[2] See note under granodiorite (229) and leuco-granogabbro (139).

Rhyobasalt. To have a term analogous to granogabbro, the term rhyobasalt is here used. See note under granodiorite (229).

(2310) Quartz-gabbro.
Quartz-olivine-gabbro.
Quartz-basalt.
Quartz-olivine-basalt.

(2312) **Calci**syenite. No modal analysis of a plutonic rock belonging here has yet been located.

Vulsinite Washington. Vulsinites are defined by Washington[3] as "effusive rocks occupying an intermediate position between the trachytes and the andesites. They are characterized mineralogically by the presence of alkali feldspar with a large amount of basic plagioclase (labradorite to anorthite) together with augite and diopside. Hornblende and biotite are not abundant in the type specimens, though they may be present in large amounts in other varieties. . . . . Olivine is wanting, or if present is so in only accessory amounts." While the definition would suggest a rock of the latite series, the modal analysis of the Bolsena type[4] shows it to belong to Family 12. The mineral percentages are: soda-orthoclase (Or_9Ab_4) 69.5, basic plagioclase (anorthite phenocrysts 6.1, labradorite groundmass 11.9, average Ab_1An_2) 18.0, augite 7.4, biotite 1.0, ores 3.6, apatite 0.4, titanite 0.1.

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[1] Cross, Iddings, Pirsson, and Washington, *Quantitative Classification of Igneous Rocks* (Chicago, 1903), p. 227.

[2] Albert Johannsen, "Suggestions for a Quantitative Mineralogical Classification of Igneous Rocks," *Jour. Geol.*, XXV (1917), 89.

[3] Henry S. Washington, "Italian Petrological Sketches, I: The Bolsena Region," *Jour. Geol.*, IV (1896), 553.

[4] *Ibid.*, "The Roman Comagmatic Region," *Carnegie Publication No. 57* (Washington, 1906), p. 65.

Ciminite WASHINGTON. The quartz-free ciminite has a mode[1] of soda-orthoclase ($Or_{10}Ab_3$) 50.7 per cent, labradorite (Ab_1An_2) 13.1 per cent, augite 23.2 per cent, olivine 11.2 per cent, magnetite 0.9 per cent, apatite 0.9 per cent. See note under quartz-ciminite (237).

(2313) **Calci**monzonite. The original Monzoni monzonite, according to Brögger, usually contains a basic plagioclase (see note under 2213). In the present classification normal orthoclase-acid-plagioclase rocks are included under the term monzonite and orthoclase-basic-plagioclase (excluding anorthite) rocks under the term calcimonzonite.

Calcilatite. The extrusive equivalent of the preceding.

(2314) **Monzogabbro (monzonorite)**. The rocks which fall in this family are described in the literature as gabbros, norites, or monzonites. The term syenogabbro, originally proposed[2] for this family, is here withdrawn, and the term monzogabbro substituted for reasons stated under granodiorite (229). Another reason why syenogabbro should not be used for the plutonic rock of this family is that, by analogy, the extrusive should then be called trachy-basalt. But Bořický[3] used the term trachy-basalt for rocks which are now called monchiquites.

Basalatite. Basalatite, as intermediate between basalt and latite, is here suggested. It corresponds in form with its deep-seated equivalent, monzogabbro.

(2315) Gabbro VON BUCH. The term gabbro (*granito di gabbro*) was used by Targioni Tozzetti[4] and other writers for diallage-serpentine and related rocks from Tuscany. Von Buch[5] applied it to rocks consisting of "Saussurit oder Jade und Smaragdit, oder häufiger aus Feldspath und Smaragdit . . . . oder auch seltener aus allen diesen Substanzen vereinigt." His saussurite is altered feldspar, the jade amphibole, and the smaragdite probably green diallage. For a long time the name continued to be applied to plagioclase-diallage rocks, but in recent years the kind of pyroxene has been disregarded, and only the basic character of the plagioclase has been considered essential to the definition. In the present classification, therefore, gabbro is simply a rock consisting essentially of labradorite or bytownite and a biopyribole. Olivine may be an accessory, and magnetite is usually present in variable amounts. The orthoclase-gabbro of Streng[1] and Irving[2] is really diallage-monzonite or monzodiorite.

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[1] Henry S. Washington, "The Roman Comagmatic Region," *Carnegie Publication No. 57* (Washington, 1906), p. 32.

[2] Albert Johannsen, *op. cit.*, p. 89.

[3] Emanuel Bořický, "Petrographische Studien an den Basaltgesteinen Böhmens," *Arch. f. d. naturw. Landesdurchf. v. Böhmen*, II (1874), Abt. ii, Th. ii, p. 44.

[4] Targioni Tozzetti, *Relazioni d'alcuni viaggi fatti in diverse parti della Toscana* (Firenze, 1768), II, 432.

[5] Leopold von Buch, "Ueber den Gabbro" (read in Akad. d. Wissens., Berlin, October 12, 1809), *Magazin d. Gesell. naturf. Freunde z. Berlin*, IV (1810), 128–49.

Hornblende-gabbro.
Olivine-gabbro.
Quartz-gabbro.
Uralite-gabbro, etc.

Norite ESMARK. Esmark[3] applied the name norite to certain Norwegian rocks which belong in part to the rocks now called norites, but in part to the diorites. Scheerer[4] applied it to rocks related to the gabbros and hyperites. Rosenbusch[5] limited it to rocks containing essential hypersthene and plagioclase, and said that unless so limited the term would be meaningless, and later[6] gave the constituents as basic plagioclase and an orthorhombic pyroxene. In this sense it is now generally used.

Hyperite TÖRNEBOHM. These rocks, intermediate between gabbros and norites, and containing both orthorhombic and monoclinic pyroxenes, were originally called hypersthenites by Rose.[1] The name was too suggestive of a rock entirely composed of hypersthene; therefore Törnebohm[2] gave to them the name hyperite, although this term had previously been used by Senft[3] for his group composed of eclogites, gabbros, and hypersthenites.

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[1] Aug. Streng, "Über die kristallinischen Gesteine von Minnesota in Nordamerika," *Neues Jahrb.* (1877), pp. 113–38.

[2] Roland Duer Irving, "The Copper-bearing Rocks of Lake Superior," *U.S. Geol. Surv., Mono. 5* (1883), pp. 50–52.

[3] Esmark, *Magazin für Naturvidenskaberne*, I, 207.

[4] Th. Scheerer, *Gaea Norvegica*, Heft ii, 313; also "Geognostisch-mineralogische Skizzen gesammelt auf einer Reise an der Süd-Küste Norwegens," *Neues Jahrb.* (1843), p. 668.

[5] H. Rosenbusch, *Mikroskopische Physiographie der massigen Gesteine* (1st ed.; Stuttgart, 1877), p. 477.

[6] *Ibid.* (4th ed., 1907), p. 348.

Syn.: Hypersthene-syenit, Hypersthenite Rose, Hypersthene-gabbro, Augite-norite, etc.

Basalt. The derivation of the term is unknown. It may be derived from the Ethiopian *bsalt*, "cooked," suggesting a baked rock, or from *barzalten*, *barzel*, the Hebrew for "iron." Pliny[4] speaks of "basalten" found in Ethiopia, a rock which "in color and hardness resembles iron, and is used in making statuary." Agricola[5] thought that certain rocks in Saxony were identical with the basalt of the older writers, and applied this term to them, and Werner[6] used it for the same rocks, which he considered sedimentary. Basalt is the extrusive equivalent of gabbro, and in general the term is applied to rocks with basic plagioclase and augite, with or without olivine. Some writers apply the term to plagioclase-augite rocks with olivine, irrespective of the kind of plagioclase, though in general, at the present time, this is not the basis of separation from the andesites. On the basis of the feldspar, therefore, there would be

With acid plagioclase	Hornblende-andesite Augite-andesite Olivine-augite-andesite, etc.
With basic plagioclase	Hornblende-basalt Basalt (with pyroxene) = Auganite Winchell Olivine-basalt, etc.

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[1] G. Rose, "Über Hypersthenit," *Pogg. Ann.*, XXXIV (1835), 10.

[2] A. E. Törnebohm, "Über die wichtigeren Diabas- u. Gabbro-Gesteine Schwedens," *Neues Jahrb.* (1877), p. 379.

[3] Ferdinand Senft, *Classification und Beschreibung der Felsarten* (Breslau, 1857), p. 59.

[4] C. Plinii Secundi *Naturalis Historiae* xxxvi. cap. vii. Ed. Lugd. Batav. Roterodami, Ao. 1668, p. 645.

[5] Georg Agricola (Georg Bauer), *De re metallica*, 1556.

[6] A. G. Werner, "Bekanntmachung einer . . . . über die Entstehung des Basaltes gemachten Entdeckung . . . . ," *Bergmänn. Journ.*, Pt. II (1788), p. 845.

Winchell[1] suggests the word auganite for olivine-free basalt, and uses basalt for the olivine-bearing variety. The writer prefers basalt and olivine-basalt for these rocks.

According to their textures, basalts have been divided into three groups: basalts proper, anamesite, and dolerite.

Basalt proper. Compact, dense, aphanitic.

Anamesite VON LEONHARD.[2] Megascopically crystalline, but fine-grained. Name derived from ἀνάμεσος, "in the middle."

Dolerite HAÜY,[3] from δολερὸς, "deceptive." Coarse-grained.

Alboranite BECKE. Becke[4] proposed the term alboranite for certain extrusive rocks from the island of Alboran. They consist of hypersthene and basic plagioclase. The phenocrysts in the rocks described by him are anorthite and the groundmass microlites labradorite. The rocks thus are olivine-free hypersthene-basalts, and, as extrusive representatives of norite, deserve the new name. See note under santorinite (2215).

(2323) Kulaite WASHINGTON. This term was originally applied by Washington[5] to certain extrusive rocks from the volcanoes of Kula, in Lydia, Asia Minor, under the impression that they were hornblende-basalts. Later they were shown by him[6] to be nephelite-bearing and to contain approximately equal amounts of orthoclase and basic plagioclase. No plutonite of this composition has yet been located among modes given in the literature; therefore kulaite is temporarily used as the family name. The term should not be confused with kullait HENNIG.

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[1] Alexander N. Winchell, "Rock Classification on Three Co-ordinates," *Jour. Geol.*, XXI (1913), 215; also "Geology of the National Mining District, Nevada," *Mining and Scientific Press*, CV (1912), 657.

[2] Karl Cäsar von Leonhard, *Die Basalt-Gebilde in ihren Beziehungen zu normalen und abnormen Felsmassen* (Stuttgart, 1832), I, 151.

[3] Ascribed to Haüy by Alexandre Brongniart, *Classification et caractères minéralogiques des roches* (Paris, 1827), p. 101.

[4] F. Becke, "Der Hypersthen-Andesit der Insel Alboran," *Tscherm. Min Petr. Mitth.*, XVIII (1899), 553.

[5] Henry S. Washington, "On the Basalts of Kula," *Amer. Jour. Sci.*, XLVII (1894), 115.

[6] *Ibid.*, "The Composition of Kulaite," *Jour. Geol.*, VIII (1900), 618.

Loewinson-Lessing[1] expressed the opinion that kulaite is the extrusive equivalent of heumite, with which the present writer does not agree. Heumite is described by Brögger[2] as a rock essentially of soda-orthoclase or soda-microcline with other feldspars, very small amounts of nephelite and sodalite, and considerable barkevikite and biotite. Furthermore, the leucocratic minerals in heumite form only 53 per cent of the rock, and the subordinate plagioclase is oligoclase-albite, and not basic plagioclase.

(2324) **Nephelite-(leucite-)monzogabbro.** A term suggested here for the nephelite-(leucite-)bearing rocks of the basic plagioclase series, and comparable to the granogabbros among those bearing quartz. Nephelite-syenogabbro, suggested previously,[3] is withdrawn. See notes under (229) and (2314).

Essexite SEARS is quite variable, but probably belongs here or to (2325), or to both, although the original description by Sears[4] does not mention the presence of orthoclase. He says it contains augite, hornblende, biotite, plagioclase, and nephelite with the usual accessories. Washington,[5] describing the same rock, says that it is essentially a basic monzonitic rock in which feldspathoids and both lime-soda and alkali feldspars are present. The feldspar ranges from Ab_1An_1 to Ab_1An_2, and "an alkali-feldspar is not uncommon . . . . often microperthitic." Nephelite is fairly abundant. In another specimen the plagioclase was Ab_1An_3 and only a few grains of alkali-feldspar were seen. Speaking of certain other rocks described as essexites, Washington[6] says that since they contain neither nephelite nor alkali-feldspar, they are not essexites. Many rocks, clearly not essexites, have been described under this name. The original rock is apparently of Class 2 (though some recently described essexites are of Class 3), and certainly of Order 3.

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[1] F. Loewinson-Lessing, "Kritische Beiträge zur Systematik der Eruptivgesteine, V," *Tscherm. Min. Petr. Mitth.*, XXI (1902), 322.

[2] W. C. Brögger, *Die Eruptivgesteine des Kristianiagebietes. III: Das Ganggefolge des Laurdalits* (Kristiania, 1898), pp. 98–113.

[3] Albert Johannsen, "Suggestions for a Quantitative Mineralogical Classification of Igneous Rocks," *Jour. Geol.*, XXV (1917), 89.

[4] John H. Sears, "Elaeolite-Zircon-Syenites and Associated Granitic Rocks in the Vicinity of Salem, Essex County, Massachusetts," *Bull. Essex Inst.*, XXIII (1891), 146.

[5] Henry S. Washington, "The Petrographical Province of Essex County, Massachusetts," *Jour. Geol.*, VII (1899), 53–56.

[6] *Loc. cit.*

(2325) Nephelite-(leucite-)gabbro. Rouvillite O'NEILL belongs here. This is a rock from St. Hillaire, Quebec, described by O'Neill.[1] It may be called a nephelite-gabbro or light-colored theralite. Rosiwal measurements show the rock to consist of nephelite 29.35 per cent, plagioclase ($Ab_{50}An_{50}$ to $Ab_{20}An_{80}$) 55.9 per cent, apatite 1.15 per cent, pyroxene 7.50 per cent, and hornblende 3.64 per cent.

(2327) Heronite COLEMAN. While this is an analcite dike rock, and far from the center point of the family, it is the only rock so far located in this pigeonhole. The name was given by Coleman[2] to a rock from Heron Lake, north of Lake Superior, consisting of much analcite (53 per cent of the leucocratic minerals), orthoclase (28.24 per cent), labradorite (13 per cent), aegirite (4.04 per cent), and limonite and calcite.

(2330) Lugarite TYRRELL[3] is a porphyritic rock, occurring in dikes and as a sill in the Lugar teschenite-picrite complex in the west of Scotland. It consists of analcite (with some nephelite) 50 per cent, labradorite 10 per cent, apatite 2 per cent, titanaugite 20 per cent, barkevikite 15 per cent, and ilmenite 3 per cent. Tyrrell considers the analcite "original, displacing nephelite."

CLASS 2, ORDER 4

(247) **Anorthite**-granite.

(248) **Anorthite**-adamellite.

(249) **Anorthite-granogabbro.**

(2410) Quartz-anorthite-gabbro.

(2412) **Anorthite**-syenite. A syenite whose small percentage of plagioclase is anorthite may be called anorthite-syenite. Here belongs a so-called shonkinite from Elkhorn, Montana, described by Barrell.[1] It is hardly typical of the family, however, since it is near the boundary of Class 3. See note under (2112).

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[1] J. J. O'Neill, "St. Hilaire (Beloeil) and Rougemont Mountains, Quebec," *Geol. Surv. Canada, Mem. 53* (Ottawa, 1914), p. 35.

[2] A. P. Coleman, "A New Analcite Rock from Lake Superior," *Jour. Geol.*, VII (1899), 435.

[3] G. W. Tyrrell, "The Late Palaeozoic Alkaline Igneous Rocks of the West of Scotland," *Geol. Mag.*, IX (1912), 77–78.

(2413) **Anorthite-**monzonite. See note under (2113).

(2414) **Anorthite-monzogabbro.** See notes under (2114) and (2314).

(2415) Anorthite-gabbro. Here belongs an anorthite-augite dike rock from the Carlingford district, Ireland, with the percentages 62 and 38 according to a calculated analysis by Roth.[2] The corresponding extrusive rock, with more than 50 per cent anorthite, 33 per cent augite, and 8 per cent magnetite, was described as anorthite-diabase by Tschermak.[3]

Another rock belonging to this family is kyschtymite MOROZEWICZ,[4] an anorthite-corundum rock, occurring as an intrusive in granite in Kyschtym in the Urals. Still another is allivalite HARKER,[5] occurring on Allival, a mountain on the Isle of Rum and consisting of anorthite and olivine.[6] Finally, there is rougemontite O'NEILL,[7] containing anorthite 52.25 per cent, augite 32.51 per cent, olivine 8.35 per cent, hornblende 0.43 per cent, and iron ore 6.52 per cent.

CLASS 3, ORDER 1

(316) **Mela-orthogranite.** In this family fall two rocks, Prowersose (of the quantitative system of C.I.P.W.), described by Cross,[8] a dike rock from Two Buttes, Colorado, and a similar rock

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[1] Joseph Barrell, "Microscopical Petrography of the Elkhorn Mining District, Jefferson County, Montana," *U.S. Geol. Surv., Ann. Rept.*, XXII, Part II (1901), p. 519.

[2] J. Roth, *Gesteinsanalysen*, lvii. The rock was originally calculated by G. Haughton (*Quart. Jour. Geol. Soc.*, XII [1856], 197) as anorthite 85.84 per cent and augite 14.16 per cent, which was shown to be wrong by Roth.

[3] Gustav Tschermak, "Über secundäre Mineralbildungen in den Grünsteingebirge bei Neutitschein," *Sitzungsber. d. Wien Akad. d. Wiss.*, XL (1860), 127.

[4] J. Morozewicz, "Kyschtymit—ein Korund-Anorthitgestein," *Tscherm. Min. Petr. Mith.*, XVIII (1898), 202.

[5] Alfred Harker, "Igneous Rocks from the Ultrabasic Group of the Isle of Rum. Summary of Progress," *Geol. Surv.* (1903), p. 56.

[6] J. W. Judd, "On the Tertiary and Older Peridotites of Scotland," *Quart. Jour. Geol. Soc.*, XLI (1883), 389–90, 395.

[7] J. J. O'Neill, "St. Hilaire (Beloeil) and Rougemont Mountains, Quebec," *Geol. Surv. Canada, Mem. 43* (Ottawa, 1914), p. 77.

[8] Whitman Cross, "Prowersose (Syenitic Lamprophyre) from Two Buttes, Colorado," *Jour. Geol.*, XIV (1906), 165.

from Knox County, Maine, described by Bastin.[1] They are melanocratic orthogranites.

(317) **Mela**-albite-granite. A poor name, which should be replaced owing to the former use of albite-granite for a different kind of rock. See note under (217).

(318) **Mela-albite**-adamellite. See note under (218).

(319) **Mela-albite**-granodiorite. See note under (219).

(3110) **Mela-albite**-tonalite. See note under (2110).

(3111) **Mela-orthosyenite.** See note under (2111).

(3112) **Mela-albite**-syenite. See note under (2112).

(3113) **Mela-albite**-monzonite. See note under (2113).

(3114) **Mela-albite-monzodiorite.** See note under (2114).

(3115) **Mela-albite**-diorite. See note under (2115).

(3116) **Ortho**shonkinite. Weed and Pirsson[2] gave the name shonkinite (from Shonkin, the Indian name for the Highwood Mountains, Montana) to a melanocratic "granular plutonic rock consisting of essential augite and orthoclase. . . . . It may be with or without olivine, and accessory nepheline, sodalite, etcetra, may be present in small quantities." In another place[3] they state that "a triclinic striated feldspar is also present, but in no considerable amount. . . . . It is albite." The amount of albite is not mentioned, but it is included in the estimated amount of alkali-feldspar. Based on the definition, however, no albite is necessary, and by analogy with other rocks (see under (111)) the term orthoshonkinite may be applied to the rocks as defined with less than 5 per cent albite. Where the albite percentage is greater, the rock falls into Family 17 as albite-shonkinite or shonkinite simply. While the original rock contained traces of feldspathoids, by definition none is necessary, and none is shown in the mode of this rock as given by Washington.[4] It has, however, affinities with the nephelite rocks; consequently, though it may fall on the feldspar base line of the double triangle, it is to be classed with the feldspathoid rocks in Family 16. Furthermore, a modal analysis of another rock[1] shows alkali-feldspar 20 per cent, nephelite 5 per cent, sodalite 1 per cent, apatite 4 per cent, and mafites 70 per cent (10 of which is olivine). The latter rock, consequently, may be called a nephelite-shonkinite of Family 21.

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[1] Edson S. Bastin, "Some Unusual Rocks from Maine," *Jour. Geol.*, XIV (1906), 173–80.

[2] Walter H. Weed and Louis V. Pirsson, "Highwood Mountains of Montana," *Bull. Geol. Soc. Amer.*, VI (1895), 415–16.

[3] *Ibid.*, p. 412.

[4] Henry S. Washington, "The Foyaite-Ijolite Series of Magnet Cove: A Chemical Study in Differentiation," *Jour. Geol.*, IX (1901), 613.

(3117) Shonkinite. This is albite-bearing shonkinite. See note under (3116).

(3121) **Nephelite**-shonkinite. See note under (3116).

(3124) **Mela**litchfieldite. See note under (2124).

(3125) **Mela**mariupolite. See note under (2125).

(3131) Bekinkinite ROSENBUSCH and Missourite WEED and PIRSSON.

The melanocratic nephelite plutonic rock of this family is represented by bekinkinite, named by Rosenbusch[2] from its occurrence on Mount Bekinkina on the peninsula Ambavatoby, as described by Lacroix.[3] While the original rock is said to contain a small amount of anorthoclase, the definition of the type rock of Rosenbusch does not require it. He calls it a plutonic form of nephelite basalt, and says it is related to ijolite as missourite is to fergusite.

Missourite was named by Weed and Pirsson[4] from its occurrence on the Missouri River. It is a melanocratic, feldspar-free leucite rock. It contains 16 per cent leucite, 8 per cent analcite and zeolites, 50 per cent augite, 6 per cent biotite, and 5 per cent iron ore.

Farrisite BRÖGGER[5] is a melanocratic melilite rock of this family.

Mela-nephelite-basalt is the extrusive equivalent of bekinite, **mela**-leucite-basalt of missourite, and **mela**-melilite-basalt or **mela**-melilitite of farrisite. There are also analcite-basalts, most of which belong in this family, though some fall in Class 2.

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[1] Louis V. Pirsson, "Petrography and Geology of the Igneous Rocks of the Highwood Mountains, Montana," *U.S. Geol. Surv., Bull. 237* (1905), p. 104.

[2] H. Rosenbusch, *Mikroskopische Physiographie der massigen Gesteine* (4th ed.; Stuttgart, 1907), p. 441.

[3] A. Lacroix, "Sur quelques roches ijolithiques du Kilima-Ndjaro," *Bull. Soc. Min. France*, XXIX (1906), 90.

[4] Walter H. Weed and Louis V. Pirsson, "Missourite, a New Leucite Rock from the Highwood Mountains of Montana," *Amer. Jour. Sci.*, II (1896), 323; Louis V. Pirsson, "Petrography and Geology of the Igneous Rocks of the Highwood Mountains, Montana," *U.S. Geol. Surv., Bull. 237* (1905), p. 118.

[5] W. C. Brögger, *Die Eruptivgesteine des Kristianiagebietes. III: Das Ganggefolgschaft des Laurdalits* (Kristiania, 1898), p. 70.

CLASS 3, ORDER 2

(327) **Mela**granite. See note under (127).

(328) **Mela**-adamellite. See notes under (127) and (228).

(329) **Mela**granodiorite. See notes under (127) and (229).

(3210) **Mela**tonalite. See notes under (127) and (2210).

(3212) **Mela**syenite. See notes under (127). Some years ago Weed and Pirsson[1] described a rock from the Highwood Mountains as containing about equal amounts of light and dark constituents, and gave to it the name yogoite. Their series of rocks as given was:

All orthoclase, no augite = sanidinite.
Orthoclase exceeds augite = augite-syenite.
Orthoclase equals augite = yogoite.
Augite exceeds orthoclase = shonkinite.
All augite, no orthoclase = pyroxene and peridotite rocks of various types.

Later[2] they withdrew the name yogoite since they found that it fell into Brögger's monzonite group on account of the proportions of orthoclase and plagioclase. The original yogoite, computed in the present system, falls in (2212) and is a normal monzonite, but associated with it, on Yogo Peak, and called shonkinite[3] by Weed and Pirsson, are two other rocks which differ from normal shonkinites in being associated with quartz-bearing instead of with feldspathoid-bearing rocks and in containing andesine instead of albite. They also contain more soda-orthoclase than andesine. These "shonkinites," therefore, may well take upon themselves the discarded name yogoite, since they also occur on Yogo Peak, and fit into the foregoing scheme even better than the original yogoite.

(3213) **Mela**monzonite. See note under (127) and (2213). Here belongs a basic contact monzonite of the Coryell batholith, described by Daly,[1] as well as a contact rock against granite described by Miller.[2]

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[1] W. H. Weed and L. V. Pirsson, "Igneous Rocks of Yogo Peak, Montana," *Amer. Jour. Sci.*, L (1895), 479.

[2] W. H. Weed and L. V. Pirsson, "The Bearpaw Mountains of Montana," *Amer. Jour. Sci.*, I (1896) 357–58.

[3] L. V. Pirsson, "Petrography of the Igneous Rocks of the Little Belt Mountains, Montana," *U.S. Geol. Surv., Ann. Rept.*, XX, Part III (1900), p. 487.

(3214) **Melamonzodiorite.** Based on Daly's[3] average analysis of 161 basalts, as named by the original authors, Leith and Mead[4] computed the mineral composition of the average "basalt" and found that it contained oligoclase 35.4, orthoclase 10.75, augite 36.90, olivine 7.58, magnetite 5.80, ilmenite 0.73, and titanite 2.84. This rock, according to the computed mode, therefore, is not of the gabbro family at all, but of the monzodiorite. Included in Daly's average, of course, are all rocks named "basalts" by the original authors, consequently including many which at the present time would be called andesites.

(3215) **Mela**diorite. Here belong, among dike rocks, many camptonites, kersantites, and spessartites, and some diabases and basalts, though most of the latter rocks belong to Class 2. Among deep-seated rocks there are a few meladiorites.

(3217) **Oligoclase-**shonkinite. **Andesine-**shonkinite. It would be very desirable if there were terms to express the acid-plagioclases exclusive of albite (Ca*N*af, of the present system) and the basic plagioclases exclusive of anorthite (Na*Ca*f). Rosenbusch[5] found the same difficulty when in his description of granite he said: "Oligoklas steht hier und im Folgenden für sauren Plagioklas." A single term would thus cover the rocks of this family. See note under (3116).

CLASS 3, ORDER 3

(337) **Mela-calci**granite. This term is too awkward. The only modal analysis yet found in this family does not lie near the center point.

(339) **Melagranogabbro.** See notes under (127) and (239).

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[1] Reginald A. Daly, "Geology of the North American Cordillera at the Forty-ninth Parallel," *Geol. Surv. Canada, Mem. 38*, Part I (1912), p. 361.

[2] William J. Miller, "Geology of the North Creek Quadrangle, Warren County, New York," *N.Y. State Museum, Bull. 170* (1914), p. 37.

[3] Reginald A. Daly, "Average Chemical Compositions of Igneous Rock-Types," *Proc. Amer. Acad. Arts and Sci.*, XLV (1910), 224.

[4] C. K. Leith and W. J. Mead, *Metamorphic Geology* (New York, 1915), p. 74.

[5] H. Rosenbusch, *Elemente der Gesteinslehre* (Stuttgart, 1898), p. 76.

(3310) **Mela-**quartz-gabbro. Too awkward a term. There are three rocks in this family, but all of them are melanocratic hornblende-quartz-gabbros—an "abnormal hornblende-gabbro" in the Moyie sill described by Daly,[1] a quartz-bearing gabbro from the Purcell sill, also described by Daly,[2] and a hornblende-gabbro from Sepänlampi, Hauksuo, Kisko, described by Eskola.[3] The type of the family should be chosen from an augite rock.

(3314) **Melamonzogabbro.** See note under (2314). Here are included two essexites, a hornblende-gabbro, a hornblende-norite, and a so-called gabbro.

(3315) **Melagabbro.** See note under (2315). Many gabbros fall here, also a few norites, and some diabases and basalts (and "dolerites").

Melabasalt. The extrusive equivalent of the above. Arapahite Washington and Larsen[4] belongs here.

(3317) **Labradorite-(bytownite-)**shonkinite. See note under (3217).

(3324) **Mela-nephelite-monzogabbro.** See note under (2324).

(3325) Theralite Rosenbusch. Theralite, from the Greek θηρᾶν ("eagerly looked for"), was applied by Rosenbusch[5] to plagioclase-nephelite rocks first thought to be represented by certain tephrites and basanites described by Wolff.[6] True theralites, however, were first described by Wolff[7] some years later. Besides the presence of plagioclase and nephelite, these rocks are characterized by much predominating dark constituent; consequently they belong to Class 3. Among the lime-soda feldspars of the rocks classed by Rosenbusch[1] as theralites "ist die Labradoritmischung die herrschende, nach auszen hin aufsteigend bis zum Andesin, in den Kernen sinkend bis an die Grenze zum Bytownit." The average feldspar, therefore, is basic plagioclase. Olivine may or may not be present. In the rock from Costa Rica described by Wolff and called the true theralite type by Rosenbusch, who named it, the plagioclase is labradorite. The rock contains, however, a little orthoclase, not necessary in the type.

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[1] Reginald A. Daly, "Geology of the North American Cordillera at the Forty-ninth Parallel," *Geol. Surv. Canada, Mem. 38*, Part I (1912), p. 234.

[2] *Ibid.*, p. 224.

[3] Pentti Eskola, "On the Petrology of the Orijärvi Region in Southwestern Finland," *Bull. d. l. com. géol. d. Finlande* (Helsingsfors), 1914, p. 71.

[4] Henry S. Washington and E. S. Larsen, "Magnetite Basalt from North Park, Colorado," *Jour. Wash. Acad. Sci.*, III (1913), 452.

[5] H. Rosenbusch, *Mikroskopische Physiographie der massigen Gesteine* (2d ed.; Stuttgart, 1887), p. 248.

[6] J. E. Wolff, "Notes on the Petrography of the Crazy Mts., and Other Localities in Montana Territory," *Northern Transcontinental Survey* (1885), pp. 8–13.

[7] J. E. Wolff, "On the Occurrence of Theralite in Costa Rica, Central America", *Amer. Jour. Sci.*, I (1896), 271.

Kylite TYRRELL,[2] with 31 per cent labradorite, 4 per cent nephelite, 1.3 per cent analcite, 26 per cent titanaugite, 32 per cent olivine, and small amounts of ilmenite, biotite, and apatite, belongs here also. It is a plutonic rock occurring in the Kyle district of Ayrshire, whence its name.

Syn.: Olivine-theralite.

(3330) No plutonic rock has been located in this family, but a rock described as a pikrit-basalt by Quensel[3] from Juan Fernandez occurs among the extrusives. It contains 50 per cent or more of olivine.

CLASS 3, ORDER 4

(3414) **Ricolettaite.** The only rock located here is a dark calcic gabbro from Traversellitthal, north cliff of Ricoletta, Monzoni. It consists of orthoclase 5 to 7 per cent, anorthite 35 to 40 per cent, pyroxene 40 per cent, and a little biotite, olivine, and magnetite. It was described by Doelter[4] and deserves a new name.

(3415) Yamaskite YOUNG. This anorthite-augite rock from Mount Yamaska, Quebec, was described by Young.[5] A similar rock, but carrying olivine, was described by O'Neill.[6]

Olivine-yamaskite.

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[1] H. Rosenbusch, *op. cit.* (4th ed., 1907), p. 413.

[2] G. W. Tyrrell, "The Late Palaeozoic Alkaline Igneous Rocks of the West of Scotland," *Geol. Mag.*, IX (1912), 121.

[3] P. D. Quensel, "Der Geologie der Juan Fernandezinseln," *Bull. Geol. Inst. Upsala*, XI (1912), 265.

[4] C. Doelter, "Chemische Zuzammensetzung und Genesis der Monzonitgesteine," *Tscherm. Min. Petr. Mitth.*, XXI (1902), 102.

[5] G. A. Young, "Geology and Petrography of Mount Yamaska, Quebec," *Geol. Surv. Canada, Ann. Rept.*, XVI, Part H (1906), p. 16.

[6] J. J. O'Neill, "St. Hilaire (Beloeil) and Rougemont Mountains, Quebec," *Geol. Surv. Canada, Mem. 43* (Ottawa, 1914), p. 66.

(3430) Several leucitites, so called, fall here, although they are not true leucitites on account of their feldspar content. No plutonic rocks have been located.

CLASS 4, ORDERS 1 TO 3

No attempt is made in this paper to separate the orders of Class 4, since too few modes have been found in the literature to warrant the separation, and measurements by the author, so far, have been chiefly on the rocks of the first three classes. It is hoped shortly to give the modes of some of the classic types of Class 4.

Family 1.—Dunite VON HOCHSTETTER. This rock, named by von Hochstetter[1] from the Dun Mountains, New Zealand, consists of olivine with accessory chromite. The amount of chromite varies greatly. Vogt[2] says that the normal rocks carry from 2 to 5 per cent. They would thus belong to Order 1. Dunites with between 5 and 95 per cent chromite he calls chromite-dunites. With over 95 per cent chromite the rocks may be classed as chromite ores of Order 4. They are represented by the plagioclase-free varieties of Sjögren's[3] Kromit-Olivinit. In other cases the ore is magnetite, as in the magnetite-olivinite series of Sjögren, which includes plagioclase-bearing and plagioclase-free olivine-magnetite rocks. Perhaps good subdivisions would be:

Order 1. Dunite. Olivine between 100 and 95 per cent.

Order 2. Chromite-dunite and magnetite-dunite. Olivine between 95 and 50 per cent.

Order 3. **Olivine-chromitite** and **olivine-magnetitite.** Olivine between 50 and 5 per cent.

Order 4. **Chromitite** and **magnetitite.** Olivine less than 5 per cent.

Families 2 and 5.—These are the families of the mica-(amphibole-)olivine rocks. Among them are mica-peridotite and amphibole-peridotite. Mica-peridotite was named by Diller[1] from an occurrence in Kentucky. In the type rock the olivine and its alteration products form over 80 per cent, the ores, magnetite, and ilmenite together 4.2 per cent, while biotite, garnet, etc., are accessory. The rock number is (412).

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[1] Ferdinand von Hochstetter, "Dunit, körniger Olivinfels vom Dun Mountain bei Nelson, New-Seeland," *Zeitschr. d. d. geol. Gesell.*, XVI (1864), 341.

[2] J. H. L. Vogt, "Beiträge zur genetischen Classification der durch magmatische Differentiationsprocesse und der durch Pneumatolyse entstandenen Erzvorkommen," *Zeitschr. f. prak. Geol.* (1894), p. 391.

[3] A. Sjögren, "Om förekomsten af Tabergs jernmalmsfyndighet i Småland," *Geol. Fören. i Stockh. Förhandl.*, III (1876), 58.

Amphibole-peridotite was first described as amphibole-gabbro by Howitt.[2] Later Rosenbusch[3] compared the same rock with the Schreisheim dike, and still later Verbeek[4] called it amphibole-peridotite. Hornblende-peridotite is the usual variety. Rocks of this class have been called hornblende-picrites by Bonney[5] and hudsonites by Cohen,[6] but since picrite was originally used for an olivine-augite rock and hudsonite for a variety of diallage, Williams[7] proposed for them the name cortlandtite.

A rock whose present mode places it in Family 5 is scyelite JUDD.[8] It consists of hornblende 58.5 per cent, serpentine after olivine 22 per cent, mica 18.5 per cent, and magnetite 1 per cent. Judd says that the hornblende is probably secondary after augite; therefore it possibly should be placed in Family 11.

Families 3, 6, and 10.—In these pigeonholes fall valbellite SCHÄFER[9] and some of the olivinites of SJÖGREN[10] and

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[1] J. S. Diller, "Mica-Peridotite from Kentucky," *Amer. Jour. Sci.*, XLIV (1892), 289; also "Peridotite of Elliott County, Kentucky," *U.S. Geol. Surv., Bull. 38* (1887), p. 11.

[2] A. W. Howitt, "The Diorites and Granites of Swift's Creek and Their Contact Zones, with Notes on the Auriferous Deposits," *Proc. Roy. Soc. Victoria*, 1879.

[3] H. Rosenbusch, review of preceding article, *Neues Jahrb.*, I (1881), 221.

[4] R. D. M. Verbeek, *Topographische en geologische beschrijving van een gedeelte van Sumatra's Westkust* (Batavia, 1883), p. 304; also "Description géologique de l'Ile d'Ambon," *Jaarboek van het Mijnwegen in Nederl. Oost-Indie*, XXXIV (1905).

[5] T. G. Bonney, "On a Boulder of Hornblende-Picrite Near Pen-y-Carnisiog. Anglesey," *Quart. Jour. Geol. Soc.*, XXXVII (1881), 137.

[6] E. Cohen, "Berichtigung bezüglich des 'Olivin-Diallag-Gesteins' von Schriesheim im Odenwald," *Neues Jahrb.*, I (1885), 242.

[7] G. H. Williams, "The Peridotites of the 'Cortlandt Series' on the Hudson River Near Peekskill, New York," *Amer. Jour. Sci.*, XXXI (1886), p. 30, note.

[8] John W. Judd, "On the Tertiary and Older Peridotites of Scotland," *Quart. Jour. Geol. Soc.*, XLI (1885), 401–7.

[9] Raimund William Schäfer, "Der basische Gesteinszug von Ivrea im Gebiet des Mastallone-Thalles," *Tscherm. Min. Petr. Mitth.*, XVII (1897), 512–14.

[10] A. Sjögren, "Om förekomsten af Tabergs jernmalms fyndighet i Småland," *Fören. i Stockh. Förhandl.*, III (1876), 58.

EICHSTÄDT.[1] Valbellite consists of bronzite, olivine, and brown hornblende in variable amounts, with accessory magnetite, green spinel, and pyrrhotite. The magnetite may be very abundant. Olivinite covers a group of rocks of varying composition. Essentially they contain olivine with augite and hornblende. Anorthite may be present in some occurrences, but in general it is rare. Another rock belonging here is Saitzew's[2] hornblende-diallage-peridotite from the Koswinski-Kamenj, in the Urals, later described by Duparc and Pearce[3] under the name koswite. This rock consists of much diopside, less olivine and less hornblende in a cement of magnetite, giving a sideronitic texture. Chrome spinel is also present. The main characteristic is the texture, which, the authors say, passes to that of ordinary peridotite by a decrease in the amount of magnetite. The sideronitic texture is not confined to these dikes, but also occurs in other magnetite-rich peridotites.

Families 4 and 11.—This group includes the olivine-pyroxene (both orthorhombic and monoclinic) rocks. Among them are lherzolite DE LAMÉTHERIE,[4] named from the original locality of Lherz, in the Pyrenees, and consisting of olivine, enstatite, and diopside, with accessory picotite. In other localities the pyroxene is diopside and bronzite, and chromite may be present in small amounts.

Diallage-peridotite KLOOS[5] consists of diallage, olivine, and some chromite.

Wehrlite is a name given by von Kobell,[6] in 1834, to a rock from Wehrle in Hungary, under the impression that it was a mineral.

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[1] Fr. Eichstädt, "Pyroxen och amfibolförande bergarter från mellersta och östra Småland," *Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar*, XI, No. 14 (1887), pp. 95, 123.

[2] A. Saitzew, "Geologische Untersuchungen im Nikolai-Pawdinschen Kreise und Umgebung, im Gebiete des Central-Ural und dessen östlichen Abhang," *Mem. Com. Geol.*, XIII, No. 1 (1892), p. 91.

[3] L. Duparc and F. Pearce, "Sur la koswite, une novelle pyroxénite de l'Oural," *Comptes Rendus*, CXXXII (1901), 892–94.

[4] De Lamétherie, *Théorie de la terre*, II, 281; also *Leçons minéralogique*, II, 206.

[5] J. H. Kloos, "Über Uralit und die strukturellen Verschiedenheiten der Hornblende in einigen Gesteinen des Schwarz- und Odenwaldes," *58 Vers. deutsch. Naturf. u. Arze* (Strassburg, 1885); also "Studien im Granitgebiet des südl. Schwarzwaldes," *Neues Jahrb.*, III (1884), 146.

[6] Franz von Kobell, *Geschichte der Mineralogie* (München, 1864), p. 660.

The name is now generally applied to peridotites with olivine and much diallage or augite, although the type rock actually contains considerable hornblende and belongs to Family 3, 6, or 10.

Harzburgite ROSENBUSCH[1] and saxonite WADSWORTH[2] were applied to peridotites composed of olivine and a monoclinic pyroxene. Vogt,[3] following Brögger, uses saxonite for the iron-poor olivine-enstatite rocks and harzburgite for the iron-rich members. A saxonite from Minnesota, described by Hall,[4] consists of enstatite 60 per cent, olivine 35 per cent, and ores 5 per cent, consequently belongs to (4211).

Families 7 and 9.—These are the families of the olivine-free amphibole-(or biotite-)pyroxene rocks. Here belong Cromaltite SHAND,[5] consisting of aegirite-augite 51.9 per cent, melanite 15.6 per cent, biotite, apatite, and ores. Its number is (429). A hornblende-hypersthenite, named bahiaite by Washington,[6] with the percentages hypersthene 46, augite 5, hornblende 40.7, and ores 8.3 (rock number 429), also belongs here. Washington says olivine is negligible in bahiaite, but one such rock described by him[7] contains 7.5 per cent, which places it in Family 10.

Family 8.—This is the family of the amphibolites and hornblendites. Among these is a hornblendite from Brazil, described by Washington.[8] It consists of hornblende 91.6 per cent, olivine 3.6 per cent, and magnetite 5.1 per cent.

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[1] H. Rosenbusch, *Mikroskopische Physiographie der massigen Gesteine* (2d ed.; Stuttgart, 1887), p. 269.

[2] M. E. Wadsworth, *Lithological Studies* (Cambridge, Mass., 1884).

[3] J. H. L. Vogt, "Beiträge zur genetischen Classification der durch magmatische Differentiationsprocesse und der durch Pneumatolyse entstandenen Erzvorkommen," *Zeitschr. f. prak. Geol.* (1894), p. 384, note.

[4] C. W. Hall, "The Gneisses, Gabbro-Schists, and Associated Rocks of Southwestern Minnesota," *U.S. Geol. Surv., Bull. 157* (1899), p. 111.

[5] S. J. Shand, "On Borolanite and Its Associates in Assynt," *Trans. Edinburgh eol. Soc.*, IX (1910), 394.

[6] Henry S. Washington, "The Charnockite Series of Igneous Rocks," *Amer. Jour. Sci.*, XLI (1916), 331–32.

[7] *Ibid.*, "An Occurrence of Pyroxenite and Hornblendite in Bahia, Brazil," *Amer. Jour. Sci.*, XXXVIII (1914), 86.

[8] *Ibid.*, p. 82.

Another rock belonging here is the biotite-pyroxenite from New Zealand described by Hutton.[1] It consists of biotite and hornblende in about equal proportions.

Family 12.—Finally, in Family 12, belong the pure pyroxene rocks, such as diallagite, bronzitite, hypersthenite (together called pyroxenolites by Lacroix).[2] Websterite WILLIAMS,[3] named from Webster, North Carolina, contains both orthorhombic and monoclinic pyroxenes with accessory iron ores.

Ilmenite-enstatitite VOGT[4] contains as much as 60 per cent ilmenite; consequently it ranges from Order 2 to 3. A magnetite-pyroxenite described by Jennings[5] and Bastin[6] also belongs to Order 3. It contains 67.25 per cent magnetite, 8.30 per cent ilmenite, 16.89 per cent diopside or augite, 6.70 per cent spinel, and .18 per cent apatite.

APPENDIX

This appendix might be introduced by the Spanish proverb: "El sabio muda consejo, el necio no," were there no danger of some critic replying with: "Prudentis est mutare consilium; stultus sicut luna mutator."

In the first instalment of this paper (p. 38), the writer spoke of a contemplated change by which seventy-two families were to be omitted, but letters sent to a considerable number of petrographers found no uniformity of opinion. Some were in favor of dropping all the rocks of the monzonitic series, others of retaining all; some favored dropping the quartz-monzonites but not the monzonites, others dropping the monzonites but not the quartz-monzonites. During the past year, while the foregoing paper was awaiting its turn for publication and while going through the press, the writer collected and determined many more modes and found that the monzonitic group is unnecessary except possibly in the granite-granodiorite and syenite-diorite series. Now apparently the only monzonites which anyone desires to retain are those of these two groups. Consequently the writer believes the following changes will satisfy all sides.

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[1] F. W. Hutton, "On a Hornblende-Biotite Rock from Dusky Sound, New Zealand," *Quart. Jour. Geol. Soc.*, XLIV (1888), 745–46; also "The Eruptive Rocks of New Zealand," *Jour. and Proc. Roy. Soc. New South Wales*, XXIII (1889), Part I, p. 154.

[2] A. Lacroix, "Sur les roches basiques constituant des filons minces dans la lherzolite des Pyrénées," *Comptes Rendus*, CXX (1895), 752–55.

[3] George H. Williams "The Non-feldspathic Intrusive Rocks of Maryland and the Course of Their Alteration," *Amer. Geol.*, VI (1890), 40–41.

[4] J. H. L. Vogt, "Bildung von Erzlagerstätten durch Differentiationsprocesse in basischen Eruptivmagmata," *Zeitschr. f. prak. Geol.* (1893), p. 8.

[5] E. P. Jennings, "A Titaniferous Iron-Ore Deposit in Boulder County, Colorado," *Trans. Amer. Inst. Min. Eng.*, XLIV (1913), 14–25.

[6] Edson S. Bastin, "Economic Geology of Gilpin County and Adjacent Parts of Clear Creek and Boulder County, Colorado," *U.S. Geol. Surv., Prof. Paper 94* (1917), p. 47.

All classes and orders are to be subdivided as stated on pages 38 to 40. Families are to be divided and numbered hereafter as shown in Figure 7 instead of as in Figure 4, the divisions being at 0–5–50–95–100. In the case of the quartz-monzonites-granodiorites, and syenites-monzonites-monzodiorites (Families 7–8–9, and 12–13–14, Fig. 4), subdivisions *may* be introduced if desired with the 0–5–35–65–95–100 per cent limits as before. In such cases they will be numbered, to conform with the new family numbers, 5, 6′, 6′–7′, 7′, 8, 9, 10′, 10′–11′, 11′, 12. Therefore, for example:

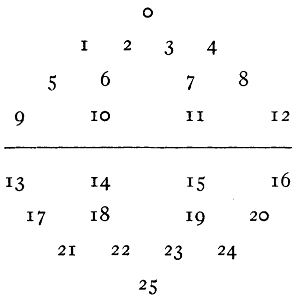

FIG. 7.—The new subdivisions for families

226 is normal granite with the Kf-Plag ratio between 95–5 and 50–50.

2210 is normal syenite with the same Kf-Plag ratios.

227 is granodiorite as originally intended by Lindgren (p. 168 above) with the Kf-Plag ratio 50–50 to 5–95. (Family 237 is granogabbro.)

2211 is normal syenodiorite (2311 syenogabbro) with Kf-Plag ratio like the preceding.

For those who wish to use the monzonitic subfamilies:

226′ is more limited granite with the Kf-Plag ratio between 95–5 and 65–35. It may be called monzogranite.

2210′ is limited syenite with the same Kf-Plag ratios. It may be called monzosyenite.

226′–7′ is quartz-monzonite or adamellite, Kf-Plag ratios 65–35 to 35–65.

2210′–2211′ is monzonite, with same ratios as preceding.

227′ is limited granodiorite with Kf-Plag ratios between 35–65 and 5–95. Better called monzotonalite, leaving granodiorite for 227.

2211′ is monzodiorite, same ratios as preceding.

Thus petrographers who wish to use quartz-monzonite and monzonite have subfamilies at their disposal and these subfamilies may be carried through the whole system if desired. Normally only the families would be used.

So far as names are concerned, they remain as given in the preceding article except that Families 3, 8, 13, 18, 23, and 28 drop out entirely and the adjacent families (and their names) extend to the center line.

In Class 4 the subdivisions are to be made on the same divisions, therefore the left face of Figure 5 should be divided as the upper half of Figure 7 and the positions computed in the same manner as the families in the other classes.

In Part I, therefore, the following changes are to be made in the rules on pages 43 and 44.

Page 43, 3 lines from bottom, *omit* five.

Page 44, lines 7–8, *for* 0–5–35–65–95–100 *read* 0–5–50–95–100.

Page 44, lines 12–14, *for* the mineral of one corner, etc., to end of sentence, *read* olivine to the sum of the biopyriboles, and of biotite plus amphibole to pyroxene.

Another correction that should be made is on page 42, where zinnwaldite is to be taken away from the auxiliary constituents and added to the dark micas under mafites.

The principal advantage of the system as it now stands is in the rapidity with which a rock may be classified. It is much easier to determine whether the potash feldspar is greater or less in amount than the plagioclase than it is to estimate whether it falls between the 5–35–65–95 limits.